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(54) **Anchoring structure and method of anchoring a frescoed plaster layer to a wooden plaster-holding timber frame of a building ceiling**

(57) An anchoring structure designed to anchor a plaster layer (300) to a plaster-holding timber frame (200) of a building ceiling (100). The plaster-holding timber frame (200) comprising slots (220) and said plaster layer (300) having an upper surface (300a) facing the plaster-holding timber frame (200) and shaped so as to slip/be inserted in the slots (220) to form anchoring ribs (310). The anchoring structure (1) comprising a plurality of mechanical anchoring members (2), which are firmly con-

nected to the ribs (310) and extend over the plaster-holding timber frame (200) so as to rest on the upper surface (200b) thereof. The mechanical anchoring members (2) comprising anchoring portions designed to be firmly inserted in holes (5) which are made in the ribs (310) or in the plaster layer (300) in/near said fixing points. The anchoring structure (1) further comprises a fixing mixture which is injected in the holes (5) to embed the anchoring portion inside the hole (5) to cause the anchoring portion to be fixed to the plaster layer (300).

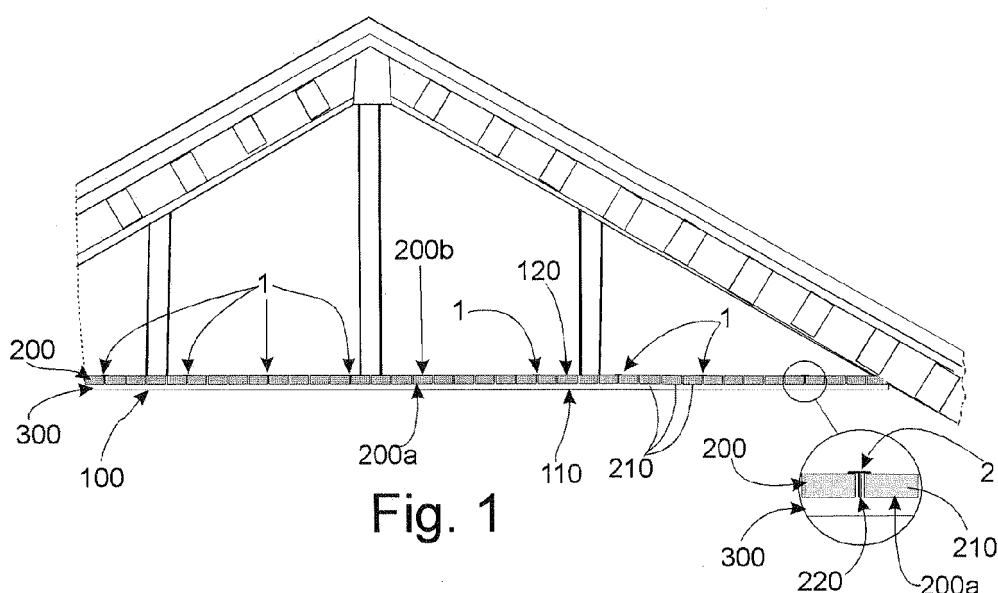


Fig. 1

Description

[0001] The present invention relates a system or structure and a method to anchor a plaster layer to a wooden plaster-holding timber frame of the ceiling of an ancient building, as for instance a mansion or a church; to which the following description refers purely by way of example.

[0002] It is known that in antiquity, meaning until the nineteenth century, the technique used to effectuate building ceilings (for example mansions or churches) which were intended to be frescoed, was after all common and essentially foresaw: first of all to prepare, in correspondence of the ceiling, a wooden plaster-holding timber frame made by a number of small wooden beams or wooden laths (usually designed by the Italian term "arelle") stretching rectilinear, and parallel and spaced to each other in order to form grooves and slits; apply a layer of plaster of prearranged thickness made by lime, mixed with silicon sand, the latter composed of calcium carbonate, onto the inferior surface of the wooden plaster-holding timber frame in order to cover completely the inferior surface and causing part of the plaster to penetrate in the slits, entering/seeping into in the slits forming crests or anchoring rigid ribs, partially overabundant onto the superior surface. Thanks to the process of hardening and consolidation of the plaster (also known as process of carbonation of the plaster), the ribs remain held by and anchored to the laths. In this case, each of the ribs of the plaster layer presents an end coming out, meaning that the end stretches onto two consecutive laths and it is shaped in order to form an anchoring tab leant on the laths, so to prevent the rib in slipping out from the slits, anchoring in such way the plaster layer to the timber frame.

[0003] It is also well known that recently, in many building ceilings made based on the above explained technique, cracks and fissures/splits have occurred, and it has been found that remarkable parts of the plaster layer have come off the timber frame. This detachment, not only puts in danger heavily both people and things underneath the ceiling, but also damages remarkably the fresco, generating many and multiple problems concerning the artistic damage provoked, as well as in economic terms.

[0004] Studies carried out by the Applicant have shown that the causes of the detachment of the plaster layer from the timber frame are associated both to the vibrations generated by the multiple noise sources present or transiting in correspondence of the buildings, such as motor vehicles (non-existent in antiquity), both to wide thermic fluctuations originated inside the buildings by the use of heating systems, which also were not used in antiquity.

[0005] More specifically, external vibrations investing the building stress mechanically the structure of the roof which, is also performing in many cases a load-bearing function, supporting the timber frame, transfers part of such solicitations to the layer of plaster of the ceiling causing it to be damaged.

[0006] Moreover, the sudden thermal shocks caused by heating systems inside the building, determine, especially in relatively crowded buildings such as churches, also relevant humidity variations in correspondence of the ceiling. The moisture is absorbed and released cyclically by the laths and by the layer of plaster, causing on both different dimensional variations determining a progressive crumbling of the ribs, in particular of the ends, and therefore weakening the mechanical anchoring of the plaster to the timber frame until the anchoring becomes inexistent.

[0007] The technique known to date used to consolidate the anchoring of the plaster layer to the frame, essentially provides to pour on the top surface of the frame, i.e. on the so-called extrados surface, a certain amount of consolidating liquid resin of film forming kind. The liquid resin gradually penetrates into the cracks/fissures present in the layer of plaster, in the space between the ribs and the laths, and through the slots of the boards themselves and, once solidified, makes the portions of plaster, and the laths impregnated, mutually holding.

[0008] The consolidation technique to anchor plaster by pouring consolidating resin, as described above, has many technical problems, unsolved to present.

[0009] In the first place, the distribution of the resin on the surface of the extrados and the degree of penetration of the same within the layer of plaster is hard to control. Therefore it happens quite often, in particular in ceilings with a thin layer of plaster, that the resin soaks completely through the plaster layer until reaching its outer surface and impregnate accidentally the fresco as well, incorporating with the surface of the latter and oxidises the particles deposited over time on the fresco. The presence of resin consolidated above the fresco causes an irreversible damage and most importantly a damage on the fresco itself. In fact, the removal of the resin is possible only using solvents, which on the one hand allow to remove oxides and/or particles embedded in the resin, but on the other heavily affect the pigments of the fresco, deteriorating them.

[0010] Furthermore, having the resin a composition so-called "film-forming", it produces a skin that covers the plaster layer and the laths, reducing their transpiration and dehumidification and thus causing, on the one hand, a progressive oxidation on the fresco, which darkens over time, and on the other a barrier preventing the humidity present inside the building to properly penetrate the ceiling and flow freely towards the external environment.

[0011] In cases where the technique of application of the resin is carried out properly, the resin penetrates selectively between the crumbling portions of the ribs so as to form a partial waterproofing of the ceiling which covers the ribs, leaving nevertheless uncovered the laths.

[0012] However, in this case the humidity present in the ceiling concentrates in the laths resulting in an important change in their dimensions and thus causing a greater erosion on the ribs.

[0013] GB 475 347 discloses a system designed to

suspend or support heating or cooling pipes embedded in the concrete or material forming the wall, floor or ceiling of the building.

[0014] US 2007 0029 025 discloses a method for adhering a first structure to a second structure wherein the method comprises: applying an adhesive composition to the surfaces, the adhesive composition comprising a first polymer or another polymer, and allowing the adhesive composition to bond the surfaces.

[0015] GB 475 347 and US 2007 0029 025 fail to disclose a structure and a method for anchoring and/or consolidating the anchoring of a frescoed layer of plaster to a plaster-holding timber frame in wood of a building, which is designed to overcome the drawbacks above technical described.

[0016] On the contrary, GB 475 347 discloses anchoring members for anchoring a pipe to a ceiling wherein anchoring members have a shape completely unsuitable to be used for anchoring of a frescoed plaster layer to a wooden plaster-holding timber frame of a building, whereas US 2007 0029 025 suggests to use an adhesive composition, i.e. a "film-forming" polymeric composition which, if applied to a frescoed plaster layer, would produce the same technical problems disclosed above, i.e. a progressive oxidation on the fresco and a barrier preventing the humidity present inside the building to properly penetrate the ceiling and flow freely towards the external environment.

[0017] Aim of the present invention is therefore to provide a structure and a method for anchoring and/or consolidating the anchoring of a layer of plaster to a plaster-holding timber frame in wood of a building, in order to overcome the drawbacks above technical described.

[0018] This aim is achieved by the present invention since it relates to a structure and a method for anchoring a layer of plaster to a plaster-holding timber frame in wood of a building, as defined in the attached claims.

[0019] The present invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting example of the possible realization in which:

- Figure 1 is a schematic perspective view of a portion of a ceiling of a building provided with the mechanical anchoring structure according to the teachings of the present invention;
- Figure 2 is a schematic perspective view of the mechanical anchoring structure used in the ceiling shown in Figure 1 and built according to the teachings of the present invention;
- Figure 3 is a front in-elevation view of the mechanical structure of the anchor shown in Figure 2, with parts in section and parts removed for clarity;
- Figure 4 schematically shows one embodiment of the mechanical anchoring structure shown in Figure 3, in two different operating configurations;
- Figure 5 schematically shows a view of one embodiment of the mechanical anchoring structure shown

in Figures 1, 2 and 3, with parts in section and parts removed for clarity;

- Figure 6 is a longitudinal section of the mechanical anchoring structure shown in Figure 5 along the line I-I;
- Figures 7, 8, and 9 are just as many schematic embodiments of the mechanical anchoring structure shown in Figure 1 and 2;
- Figures 10 and 11 show two schematic views in front elevation of one embodiment of the mechanical anchoring structure in two different operating conditions, with parts in section and parts removed for clarity;;
- Figures 12 and 13 show two schematic views in front elevation of one embodiment of the mechanical anchoring structure in two different operating conditions;
- Figure 14 schematically shows a view of one embodiment of the mechanical anchoring structure shown in Figures 1, 2 and 3, with parts in section and parts removed for clarity;
- Figures 15, 16, 17, 18, 19 and 20 show just as many operational steps of the method for anchoring the plaster layer to the timber frame, according to the teaching of present invention; while
- Figures 21 to 23 schematically show just as many views of one embodiment of the mechanical anchoring structure shown in Figures 1 to 20, with parts in section and parts removed for clarity.

[0020] With reference to Figure 1, the number 100 indicates ceiling of a building as a whole, for example of a villa or of a church (shown only partially) having a lower surface 110 (intrados) preferably but not necessarily frescoed, facing the base of the building, i.e. the floor (not shown), and an upper surface 120 (extrados) facing the roof of the building.

[0021] In accordance with one embodiment, the ceiling 100 comprises a wooden parget-bearing frame or plaster-holding timber frame 200 connected in a known manner to the walls and / or to the roof of the building (for example through a supporting structure formed by the holding beams connected together and to the building), and a plaster layer 300 of predetermined thickness, which is anchored to the plaster holding timber frame 200 and it extends in such a way as to cover the bottom surface 200a of the latter so as to form the lower surface 110 of the ceiling 100.

[0022] In accordance with one exemplary embodiment, the plaster-holding timber frame 200 extends in a plane preferably horizontal, and comprises a plurality of beams or wooden laths 210 (Italian term "arelle"), extending preferably parallel to a longitudinal axis A in such a way as to be substantially/ preferably coplanar among them, and they are spaced apart from one another so as to determine between them grooves or embrasures 220. In accordance with one exemplary embodiment, each lath 210 may have preferably although not necessarily a

roughly rectangular section and is preferably but not necessarily about 2-5 cm wide, while the embrasure 220 has a predetermined width among the two strips 210, preferably, but not necessarily, of between about 1 to 2 cm. It should be understood that according to a different possible embodiments not illustrated, laths 201 may have a different section from rectangular section above disclosed and the ceiling 100 may have the shape of a vault and therefore the plaster-holding timber frame 200 may have an arcuate/curved shape.

[0023] As far as the plaster layer 300 is concerned, in accordance with one embodiment, it may comprise a solid mixture based on lime and calcium carbonate (limestone), and has an upper surface 300a (opposite to the bottom surface 110 in sight), which covers the lower surface 200a of the plaster-holding timber frame 200, in such a way as to form a homogeneous layer of coverage of predetermined thickness which seeps into/partially protrudes towards plaster-holding timber frame 200, inside the embrasures 220, in order to form stiff crests or ribs 310 among the laths 210, structured to anchor the layer of plaster 300 to the timber frame holding the plaster 200.

[0024] Preferably, crests or ribs 310 may be comprised in a render (render-float) sub-layer of the plaster layer 300 (in Italian "strato di intonaco di rinzafo e/o arriccio").

[0025] In accordance with one embodiment illustrated in Figures 1, 2 and 3, the present invention is essentially based on the principle of providing an anchoring mechanical structure or system 1, which is structured to be connected to the upper surface 300a of the plaster layer 300, preferably to the render (render-float) plaster sub-layer, in correspondence of a plurality of fixing points, and it extends above the upper surface 200b of the plaster-holding timber frame 200 in such a way as to lean/rest on the same in order to mechanically anchor the plaster layer 310 to the plaster-holding timber frame 200 and/or consolidate the mechanical anchoring of the same.

[0026] According to one embodiment, the mechanical anchoring structure 1 is preferably structured to be connected integrally with the plaster layer 300, preferably with the ribs 310, and extends on either side of the ribs 310 above the upper surface 200b of the plaster-holding timber frame 200 in order to lean on the same, so as to realize a mechanical anchor from above onto the plaster layer 300.

[0027] In accordance to one embodiment shown in Figures 1, 2 and 3, the mechanical anchoring structure 1 is provided with a plurality of anchoring members 2 comprising an anchoring portion designed to be coupled in a stable manner with the plaster layer 300 in correspondence to the fixing points, and a support portion, which is shaped so as to extend above, and leaning on the upper surface 200b of the plaster-holding timber frame 200 so as to at least partly lean on the same.

[0028] In accordance to one embodiment illustrated in Figures 1, 2 and 3, the anchoring portion of the anchoring member 2 comprises a preferably straight anchoring stem 3 realized in hard and/or elastic material, for exam-

ple a metallic material preferably steel or carbon fiber or any other similar material, which is inserted in a hole, preferably a blind hole 5 preferably made in the rib 310, and it is firmly fastened, i.e. in an integral manner, to the body of the rib 310 through a fixing mixture injected into the hole 5.

[0029] The Applicant has found that a fixing mixture comprising calcium carbonate, gypsum, and an acrylic or vinyl resin advantageously enables on the one hand to ensure the fixing of the anchoring stem 3 to the rib 310 of the plaster, and secondly ensures a certain degree of elasticity of the anchor.

[0030] Preferably, according to the realization shown in Figure 3, the hole 5 may be preferably formed in the central part of the top of the rib 310 and it extends inside the rib 310 towards the lower surface 110 along a preferably transverse direction to the longitudinal axis A and to the laths 210, while the anchoring stem 3 is inserted into the hole 5 in such a way that its upper end at least partially comes out from the mouth of the hole 5 itself.

[0031] In accordance with one embodiment shown in Figure 3, anchoring member 2 is further provided with a support portion comprising a support beam 4, which is connected in the middle to the upper end of the anchoring stem 3, extends on either side of the rib 310 in a direction preferably substantially transverse to the anchoring stem 3, and is structured in such a way as to lean at least partially on the upper surface of the support laths 210 which are adjacent to the embrasure 220 containing the rib 310.

[0032] In accordance with one exemplary embodiment, the support beam 4 and the anchoring stem 3 may be made of hard and/or elastic material such as steel or carbon fiber or any similar material, and may be connected firmly to one another. For this purpose the anchoring element 2 may comprise a T-shaped element designed to be inserted in the hole 5 according to the example shown in Figure 3.

[0033] According to one embodiment shown in Figure 4, the support beam 4 may be structured to be connected firmly but still in a easily removable manner to the anchoring stem 3. In accordance with one embodiment, the upper end of the anchoring stem 3 may be conveniently shaped in order to present a hole passing throughout crosswise the anchoring stem 3, inside of which is possible to insert/withdraw the support beam 4. Therefore, the support beam 4 can be joint/disjoint advantageously just as quickly and easily to the anchoring stem 3 and enables to obtain a reversible anchoring. As above described, it should be understood that in accordance with other embodiments (not illustrated) the support beam 4 may, however, be joined in a stable but removable manner end anchor 3 through any mechanical joining system (not shown).

[0034] The method for consolidating the anchoring of the plaster layer 300 to the frame 200 may include the following operative steps. With reference to Figures 15 to 20, preferably but not necessarily, the method may

include the step of removing, from the embrasures 220, the portions of crumbled plaster belonging to the ribs 310. Preferably, but not necessarily, the method may include the step of filling the empty spaces present in the embrasures 220 caused by the disintegration of the ribs 310, through the use of a consolidating dough (shown with inclined lines in Figure 16). The Applicant has found that by using a consolidating mixture including mostly calcium carbonate and gypsum, on the one hand we may obtain a high degree of fixing of the rebuilt rib 310 to the plaster layer 300 and/or to the existing part (and not crumbled) of the rib 310, and on the other the mixture determines, after its solidification, a narrowing of the width of the rib 310 which, consequently, decouples/detaches itself from the external surfaces of the laths 210 thereby making the mechanical anchoring structure 1 independent from the plaster-holding timber frame 200.

[0035] The method further comprises the steps of forming at least one hole, preferably a blind hole 5 on the ribs 310 preferably in correspondence of the predetermined fixing point (Figure 17), and preferably of injecting a certain amount of consolidating resin in the hole 5 so as to increase both the hardness of the part of rib 310a which surrounds the hole 5, and the elasticity of part itself 310a (Figure 18). The Applicant has found that by injecting into the hole 5, 1-4 milliliters consolidating of resin, preferably 3 milliliters of acrylic or vinyl resin, one may obtain a considerable increase in the hardness and elasticity of the portion of rib 310a subject to the anchor. The consolidating resin injected into the hole 5, thanks to its composition, is absorbed by the portion of rib 310a in particular by the render sub-layer, which surrounds the hole 5 by determining the localized increase of hardness and elasticity of the portion.

[0036] The method may further include the step of injecting the fixing mixture into the hole 5 (Figure 19) and insert the anchoring stem 3 of the anchoring device 2 into the hole 5 in such a way that it is embedded/drowned in the fixing mixture, contextually putting the supporting beam 4 leaning on the laths 210 (Figure 20). The fixing mixture preferably comprises calcium carbonate and/or gypsum, an acrylic or vinyl resin and it is enriched with oxygen. The Applicant has found that by enriching the fixing mixture with oxygen there is the achievement of a major increase in the number of air macromolecules present in the structure of the mixture which confers to the latter a high elasticity.

[0037] With reference to Figures 1, 2 and 3, in accordance to one embodiment, the dimensions of the anchoring stem 3, in particular its diameter and length may be varied depending of the physical and mechanical characteristics of the plaster to be anchored, i.e. the thickness of the layer of plaster 300, the height of the ribs 310, and the weight of the portion of the plaster layer 300 that the anchoring element 2 must support.

[0038] According to one exemplary embodiment, the diameter of the anchoring stem 3 may be roughly between about 0.1 mm and 0.3 mm, preferably 0.2 mm,

while its length may be between about 1 and 5 cm, preferably 3 cm. It should be however understood that the size of the hole 5 must be such as to accommodate the stem of anchor 3.

[0039] Preferably the hole 5 may have a diameter comprised between about 1 mm and 5 mm, preferably 3 mm.

[0040] Laboratory tests carried out by the Applicant have shown that one anchoring stem 3 having a diameter of 0.1 mm is designed to support a layer of plaster weighing 20 kg, while an anchoring stem 3 with diameter 0,3 mm is designed to support a layer of plaster weighing roughly 30 kg.

[0041] It should be understood that, the number and distribution of the fixing points on the upper surface of the ceiling 100 may vary depending on the intensity of the vibrations to be damped down, and on the distribution of the weight of the plaster layer 300 to be consolidated. Laboratory tests carried out by the Applicant proved that the number of fixing points and thus the number of anchor members 2 used per square meter may be between about 20 and 60 elements/ m².

[0042] The mechanical anchoring structure 1, in addition to being extremely simple and inexpensive to put in place, it makes the whole operation of anchoring completely reversible, and enables not to affect the fresco in any way, differently from what happens in the known solutions in which it is made use of a consolidating resin. It should be understood that anchoring is preferably made on the render sub-layer without causing weaken on the other plaster sub-layers.

[0043] Furthermore, the mechanical anchoring realized on the ribs 310 by the anchoring members 2 allows to dampen the vibrations transmitted to the plaster layer 300 by the plaster-holding timber frame 310. In fact, differently from the known techniques in which the consolidating resin completely sticks and unites the plaster to the framework creating a unique body therefore making them both subject to the same vibration, the anchoring members 2 made in accordance with the presente invention remain leaning on the laths 210 and, consequently, is able to move smoothly on themselves thus reducing the vibration transmitted to the anchored rib 310.

[0044] Also thanks to the achievement of a controlled decohesion of the ribs from the plaster holding frame 200, and to the use of the consolidating mixture and of the fixing mixture conferring greater elasticity and hardness to the rib portion 16, the micro-grinding of the rib 310 is significantly reduced.

[0045] With reference to Figures 1, 2 and 3, the Applicant has also found that preferably by interposing a shock absorbing element 6 between the support beam 4 of each anchoring device 3 and the upper surface of the lath 210, it is possible to lower a great deal of the vibrations transmitted from timber frame 200 to the plaster layer 300. In accordance with one example, the shock absorbing element 5 may include, for example, a cylindrical spring or an annular rubber bearing or anti-vibrating neoprene or any similar material fitting in the anchoring stem 3.

[0046] With reference to Figure 5, the Applicant has also found that preferably by interposing a reticular structure or supporting net or grid 7 between the support beams 4 of the anchorage elements 2, and the upper surface 220b of the plaster holding timber frame 200, the structural elasticity of the ceiling 100 is further increased, and consequently the capacity of the same to withstand mechanical stress caused by high intensity vibrations. For this purpose, the Applicant has realized a different embodiment shown in Figures 5 and 6, in which the mechanical anchoring structure 1 comprises the flat grid 7 which is arranged leaning/resting on the upper surface 200b of the plaster holding timber 200. In accordance with one exemplary embodiment, the upper end of the anchoring stem 3 is put inside an opening in the grid 7 in such a way as to stick out at least partially above the grid itself, while the support beam 4 is coupled to the upper end of the stem 3 and is disposed resting on the upper face of the grid 7.

[0047] It should be understood that the grid 7 increases the elasticity of the mechanical anchoring structure 1 as well as the ability to maintain the anchored layer of plaster 300 even in case of high vibrations. In fact, it should be understood that thanks to its reticular mail, the net or grid 7 is able to make slight shifts on the upper surface 220b of the plaster holding timber frame 200 and simultaneously enables the ends of the anchoring stems 3 to shift freely a few millimeters within the openings of the grid 7 and enables the beams 4 to slide a few millimeter or the surface 220b of the grid. Therefore in the case of major vibration, thanks to the combining of the anchoring members 2 to the grid 7, the anchoring structure 1 shows an elastic behavior which allows to dampen the vibrations transmitted from the frame 200, while ensuring a stable anchoring of the plaster layer 300 below.

[0048] In accordance with one embodiment illustrated in Figure 6, the grid 7 may be preferably shaped so as to present one or more transversal sections to the longitudinal axis A, shaped as an inverted V forming cross channels for ventilation/air passage designed to increase, on the one hand, the degree of transpiration of the plaster layer 300 and of the laths 210, and on the other hand, the carrying capacity of the anchoring structure 1. In accordance with one exemplary embodiment the grid 7 may be made in metallic or plastic material such as polyvinyl-acrylate and/or glass fiber and/or carbon fiber or similar. According to one exemplary embodiment the grid 7 may be metallic and correspond, for example, to the one called "Pernevometal" (registered trademark), made by Logitec System SRL.

[0049] In accordance with one embodiment shown in Figures 5 and 6, the mechanical anchoring structure 1 may comprises preferably although not necessarily a layer of carbonate mortar 9 made mostly by calcium carbonate, gypsum and an acrylic resin. The mortar layer 9 extends on the upper surface of the grid 7 of predetermined thickness, and is permanently fixed to the latter or to the ribs 310, if present, through the openings in the

grid 7 itself.

[0050] In accordance with one embodiment shown in Figures 5 and 6, the mechanical anchoring structure 1 may also comprise preferably although not necessarily at least one net or mesh 10 of elastic and flexible material, for example of elastomeric material, which may be embedded within the layer of carbonate mortar 9, if the latter is present, and is arranged on a flat surface substantially parallel to the metal grid 7. The Applicant has found that the use of the mesh 10 in elastic and flexible material, also gives a certain elasticity to the layer of carbonate mortar 9 and, consequently, increases the overall elasticity of the mechanical anchoring structure 1.

[0051] The method for consolidating the anchoring of the plaster layer 300 to the plaster holding timber frame 200 based on the example shown in Figures 5 and 6 comprises the following steps. Preferably but not necessarily, the method may involve the step of removing the portions of crumbling plaster belonging to the ribs 310 from the embrasures 220. Preferably but not necessarily, the method may include the step of filling the empty spaces present in the embrasures 220, caused by the disintegration of the ribs 310, with the consolidating mixture, in order to rebuild or complete the crumbling ribs 310 within the embrasures 220. The method may further comprise the step of forming holes 5 on the ribs 310 in correspondence of the predetermined fixing points.

[0052] In accordance with one embodiment, the method may further comprises the steps of:

- injecting preferably a given quantity of consolidating resin 15 in the hole 5 so as to increase both the hardness of the portion of rib 310a surrounding the hole 5, and the elasticity of the portion of rib 301a;
- disposing the m grid 7 leaning on the upper surface 220b of the plaster holding timber frame 200;
- injecting the mixture into the holes 5;
- inserting the anchoring stems 3 of the anchoring elements 2 in the corresponding blind holes 5 in order to immerse them in the mixture;
- coupling the support beams 4 to the anchoring stems 3 so as to arrange them leaning on the upper major surface of the metal grid 7;
- producing the layer of carbonate mortar 9 onto the metal grid 7 drowning simultaneously the flexible mesh 10 of elastomeric material, in the layer of carbonate mortar 9.

[0053] According to a different embodiment shown in Figures 7, 8 and 9, the anchoring element 2 of the mechanical anchoring structure 1 comprises a screw 12 in which the anchoring threaded stem 3 screwed to a nut 13 trapped in the hole 5 and preferably a head 12a (corresponding to the support portion) arranged outside of the hole 5 and is structured/dimensioned so as to be put leaning on the laths 210, preferably through the interposition of the cushioning element 6 according to the example shown in Figure 7, or by the interposition of the

grid 7 according to the example shown in Figure 8.

[0054] In accordance with one embodiment illustrated in Figure 9, the screw 12 may be arranged in a manner such as to present the head 12a or at least the threaded stem 4 trapped inside the hole 5, and the nut 13 disposed outside the hole 5 and shaped to be disposed in the support laths 210, preferably through the interposition of the cushioning member 6, similarly to the example shown in Figure 7, or through the interposition of the grid 7 according to the example shown in Figure 9. The Applicant has found that using a screw 12 and a nut 13 it is possible, from one side, to adjust the traction force imparted on the rib 310, and consequently on the plaster layer 300, and the other to detach the anchoring mechanical structure 1 from the plaster layer 300 in a quick, simple, and extremely cheap way.

[0055] In accordance with one embodiment illustrated in figure 10, an end of the anchoring stem of the threaded stem 4 extends outside from the mouth of the hole 5 and is sliding inserted inside of an striker element, i.e. a washer, which is preferably arranged in abutment/rest on the layer of carbonate mortar 9, if the latter is present, i.e. on the upper surface 220b of the plaster holding timber frame 200, whereas a first elastic damper element corresponding for example to a spring is fitted in the anchoring stem 4 between the head 12a of the screw 12 and the washer 14 and is designed to elastically oppose the movement of the head 12a toward the washer 14, i.e. the anchoring stem toward down under the action of the weight of the plaster layer 300.

[0056] The Applicant has found that using an elastic damper element 16 arranged between the head 12a and the washer 14 allows to further increase the damping of vibrations that plaster holding timber frame 200 transmits to the plaster layer 300.

[0057] The Applicant has further found that first elastic damper element 16 allows to detect/determine based on of its compression a critical condition indicating a possible detachment of the plaster layer 300 from plaster holding timber frame 200. In one embodiment the critical condition may be detected/determined when the distance between the head 12a and the washer 14 is preferably lower or equal to D1.

[0058] The Applicant has found that it is possible to regulate/control the damping degree/level of the plaster layer 300 and signal the critical condition, by calibrating the elastic constant spring of the spring 16.

[0059] To the aim of improving the signaling of the critical condition, the first elastic damper element 16 may be provided with annular colored portions, which, during the spring compression, superimpose one to another in order to highlight a prefixed color such that reaching of critical condition is signaled.

[0060] In accordance with one example illustrated in Figures 12 e 13, anchoring element 2 corresponding to the screw 12, differs from anchoring element 2 of the embodiment illustrated in Figures 10 e 11, because it comprises a second elastic damper element 19, i.e. a

spring, which is fitted in the portion of anchoring stem 14 which is in turn inserted in the hole 5 and is arranged between the nut 13 and the washer 14.

[0061] The Applicant has found that combined using of the first 16 and second elastic damper elements 15 further increase the damping of vibrations that plaster holding timber frame 200 transmits to the plaster layer 300.

[0062] In accordance with an embodiment illustrated in Figure 14, the anchoring portion of the anchoring member 2 comprises a first segment/portion 20 of at least one metal wire inserted in the hole 5 and embedded in the latter preferably by means of the fixing mixture, whereas the support portion of the anchoring member 2 comprises a second segment/portion 21 of the same thin metal wire.

[0063] In accordance with one exemplary embodiment, the second segment/portion 21 extends upon the wooden laths 210 and connect the first segment/portion 20 of two or more anchoring members 2.

[0064] In accordance with one exemplary embodiment, the first 20 and second segments/portions 21 of a number of anchoring members 2 may be parts of a single wire and are obtained by folding said metal wire in more points in order to be inserted in the hole 5. In accordance with one exemplary embodiment an free end of the first segment/portion 20 arranged outside from the hole may be substantially shaped as an eyelet, whereas the second segments/portions 21 is partially inserted in the eyelet.

[0065] In accordance with one exemplary embodiment illustrated in Figure 14, the mechanical structure of anchoring 1 comprises the flexible mesh 10 interposed between the second segments/portions 21 of the wires and the upper surface 200b of the plaster holding timber 200.

[0066] In accordance with one possible exemplary embodiment illustrated in Figure 14, the mechanical structure of anchoring 1 further preferably comprise a thin layer of carbonate mortar 9, which extends upon the flexible mesh 10 to embed the latter, such that an elastic and stable connection is provided.

[0067] The Applicant has found that by using a thin steel wire, a simple and cheaper anchoring mechanical structure is obtained, imperceptible to see and thus not aesthetically degrading, wherein the vibration are reduced and at the same time anchoring in the ceiling presenting a thin plaster layer is assured.

[0068] In accordance with one embodiment illustrated in Figures 21-23, the mechanical structure of anchoring 1 may comprise one or more blind holes 5, which instead of being made in the ribs 310, as disclosed in the several embodiments illustrated in Figures 1-20, are made in the wooden laths 210 and each of them presents a first portion, which extends inside of the rib 310 and a second portion which protrudes under the rib 310 and extends in the plaster layer 300 beneath.

[0069] In accordance with one embodiment illustrated in Figures 21, 22 and 23, the anchoring portion of the anchoring member 2 is inserted in the blind hole 5 and

is assigned/set such that it extends at least partially inside the second portion of the blind hole 5 made in the plaster layer 300, whereas support portion of the anchoring member 2 which is outer of the first portion of the blind hole 5 extends upon the upper surface 200b of the plaster holding timber 200 to be lean on the latter.

[0070] In accordance with one embodiment, the anchoring portion of the anchoring member 2 may be further made integral with the plaster layer 300 inside of the second portion of the hole 5, by the fixing mixture in the analog manner of the embodiments disclosed above.

[0071] It should be understood that as illustrated in figures 21-23, the embodiment of the mechanical structure of anchoring 1 illustrated in Figure 21 (wherein it is used the hole 5 made in the laths 210), may be extended to a any of embodiments disclosed above and illustrated in the Figures from 1 to 20, wherein, depending on the embodiment, it is used an anchoring threaded stem 3, and/or a grid 7, and/or the layer of carbonate mortar 9, and/or the screw 12, and/or the metallic connecting wire (illustrated in Figure 14).

[0072] In accordance with one embodiment not illustrated, the anchoring members 2 may be conveniently connected one to the other by one or more profiled preferably straight and preferably made in flexible material, which are arranged rests on the upper surface (300a) facing the plaster-holding timber frame (200).

[0073] The advantages of the mechanical structure of anchoring are evident.

[0074] First of all, the anchoring mechanical structure assures fixing of high loaded, i.e. heavy plaster layer to the plaster-holding timber frame also when it is subjected to external vibrations/mechanical stress, granting an high security for people inside the buildings.

[0075] Moreover, differently from the known techniques using consolidating liquid resin, anchoring mechanical structure made according to the present invention allows transpiration of the fresco that does not deteriorate. Moreover the anchoring mechanical structure is reversible, i.e. is uncoupled from the plaster layer at any instant and allows therefore to recover and/or remove the plaster layer from the ceiling.

[0076] Moreover, the anchoring mechanical structure is cheaper to be made and being very simple it may be quickly installed from not-skilled operators.

[0077] While the present invention has been described with reference to the particular embodiments shown in the figures, it should be noted that the present invention is not limited to the specific embodiments illustrated and described herein; on the contrary, further variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

Claims

1. An anchoring structure (1) designed to anchor a plaster layer (300) to a wooden plaster-holding timber

frame (200) of a building ceiling (100); said plaster-holding timber frame (200) being structured so as to have slots (220); said plaster layer (300) being structured to have an upper surface (300a) facing the plaster-holding timber frame (200) and is shaped so as to slip/be at least partially inserted in the slots (220) to form anchoring ribs (310);

said anchoring structure (1) being **characterized in** comprising a plurality of mechanical anchoring members (2), which are structured to be firmly connected to the ribs (310) and/or to the plaster layer (300) at a plurality of fixing points placed on said upper surface (300a) of the plaster layer (300) itself, and extend over the plaster-holding timber frame (200) so as to rest on the upper surface (200b) of the plaster-holding timber frame (200);

said mechanical anchoring members (2) comprising anchoring portions (3)(20) designed to be firmly inserted in holes (5) which are made in the ribs (310) and/or in the plaster layer (300) in/near said fixing points;

said anchoring structure (1) further comprises a fixing mixture which is injected in the holes (5) to embed said anchoring portion inside the hole (5) to cause the anchoring member (2) to be fixed to the plaster layer (300).

2. An anchoring structure according to claim 1, wherein said anchoring member (2) further comprise a supporting portion (4)(21), which is shaped to be arranged essentially astride of at least a rib (310) and extends over the plaster-holding timber frame (200) so as to be arranged at least partially rest on the upper surface (200b) of the plaster-holding timber frame (200).
3. An anchoring structure according to claims 1 or 2, wherein said supporting portion (4) and said anchoring portion (3) of said anchoring member (2) are connected to each other in a firm, yet easily removable manner.
4. An anchoring structure according to any one of the preceding claims, comprising at least one supporting net or grid (7), which is arranged/interposed between said supporting portion (4) of said anchoring member (2) and the upper surface (200b) of said plaster-holding timber frame (200).
5. An anchoring structure according to claim 4, wherein said supporting net or grid (7) has crosswise V-shaped segments which form air passage channels between the plaster layer (300) and the plaster-holding timber frame (200).
6. An anchoring structure according to claim 4 or 5, comprising a calcium-carbonate-based carbonate layer (9), which extends over said supporting grid

- (7), and/or at least one mesh (10) made of flexible material, which extends parallel to said supporting grid (7) and is connected to anchoring members (2).
7. An anchoring structure according to any one of the previous claims, wherein a hole (5) is obtained through a lath (210) of said plaster-holding timber frame (200) at one said fixing point and at least partially extends in said plaster layer (300); said anchoring portion (3) of said anchoring member (2) is structured to be firmly inserted in said hole (5).
 8. A structure according to any one of the preceding claims from 2 to 7, wherein the anchoring portion (3) of said anchoring member (2) comprises an anchoring stem (3) inserted/engaged in said hole (5); said supporting portion of said anchoring member (2) comprises a supporting beam (4), which is connected to the anchoring stem (3) and extends in a direction locally essentially crosswise to the anchoring stem (3), and is structured to as to at least partially rest on the upper surface (200b) of the plaster-holding timber frame (200).
 9. A structure according to any one of the preceding claims, wherein said anchoring portion (3) of said anchoring member (2) comprises a stem having a first threaded end screwed to a nut (13), and/or a head (12a) which is firmly connected to a second end of said stem opposite to the first end; either said head (12a) or an inner portion of threaded stem or said nut (13) being firmly entrapped within said hole (5).
 10. A structure according to any of previous claims wherein the anchoring members (2) comprises at least an damper element (6) interposed between the support portion (4) and the upper surface (200b) of the plaster-holding timber frame (200).
 11. A structure according claim 9, wherein the anchoring member (2) comprises a first elastic damper element (16), which is fitted in the anchoring stem (3) so as to be arranged outside the hole (5) between either the first or the second end of the anchoring stem (3) itself and a striker member (14) supported by the upper surface (200b) of the plaster-holding timber frame (200).
 12. A structure according to claim 11, wherein the anchoring member (2) comprises a second elastic damper element (19), which is fitted in the anchoring stem (3) so as to be arranged inside the hole (5) between either the first or the second end of the anchoring stem (3) itself and said striker member (14) supported by the upper surface (200b) of plaster-holding timber frame (200).
 13. A structure according to any one of the previous claims, wherein said anchoring portion of said anchoring member (2) comprises a first segment/portion (20) of at least one metal wire engaged/inserted in said hole (5) and embedded in the latter by means of said fixing mixture, whereas the supporting portion of the anchoring members (2) comprises a second segment/portion (21) of a thin metal wire firmly connected to the first segment/portion (20).
 14. A structure according to claim 13, wherein the second segment (21) of the metal wire extends over the plaster-holding timber frame (200) and connects the first wire segments (20) of two or more anchoring members (2) to one another.
 15. A method for anchoring a plaster layer (300) to a wooden plaster-holding timber frame (200) of a building ceiling (100); said plaster-holding timber frame (300) being structured so as to have slots (220); said plaster layer coat (300) being structured to have an upper surface (300a) facing the plaster-holding timber frame (200) and shaped so as to slip/be inserted in the slots (220) to form anchoring ribs (310); said method comprising the step of:

arranging a plurality of mechanical anchoring members (2) resting on the upper surface (200b) of the plaster-holding timber frame (200), and firmly connecting said mechanical anchoring members (2) to the plaster layer (300) at a plurality of fixing points placed on said upper surface (300a) of the plaster layer;

said anchoring members (2) comprises an anchoring portion designed to be firmly coupled either to a rib (310) and/or to the plaster layer (300), and a supporting portion, which is shaped so as to extend on the upper surface (200b) of the plaster-holding timber frame (200) to be at least partially rest on the upper surface (200b) of the plaster-holding timber frame (200);

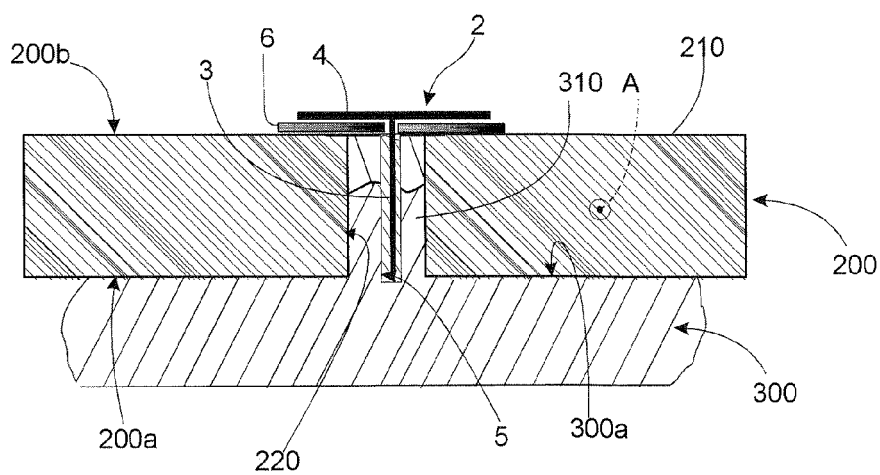
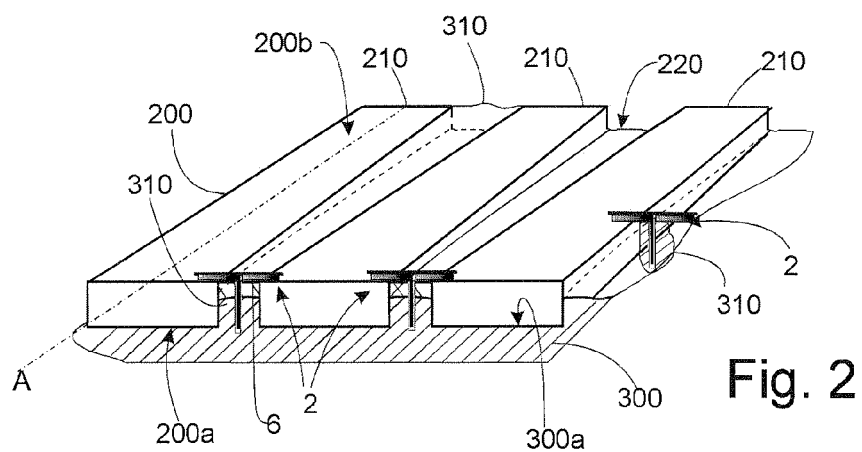
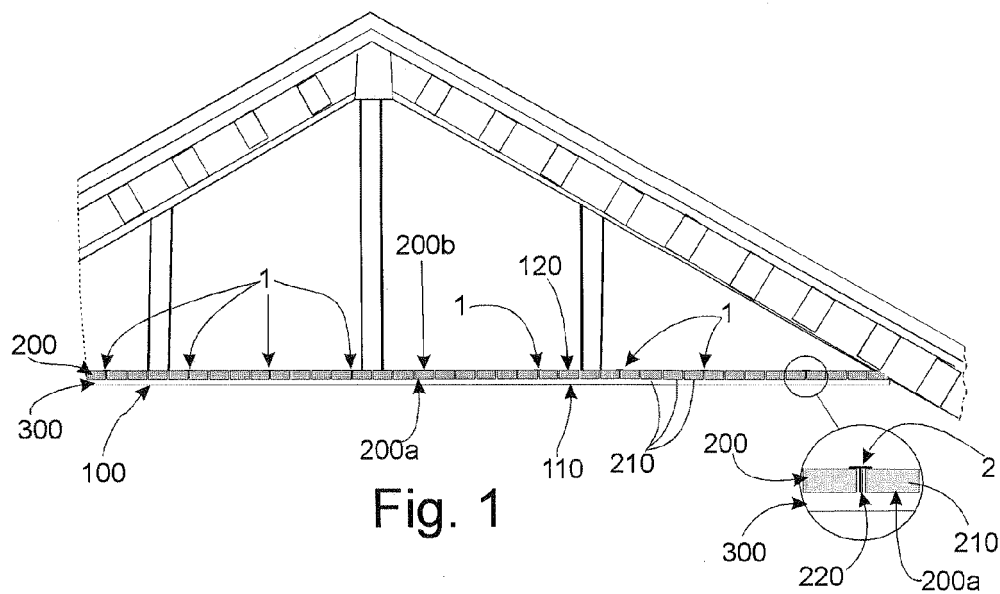
said method being **characterized in:**

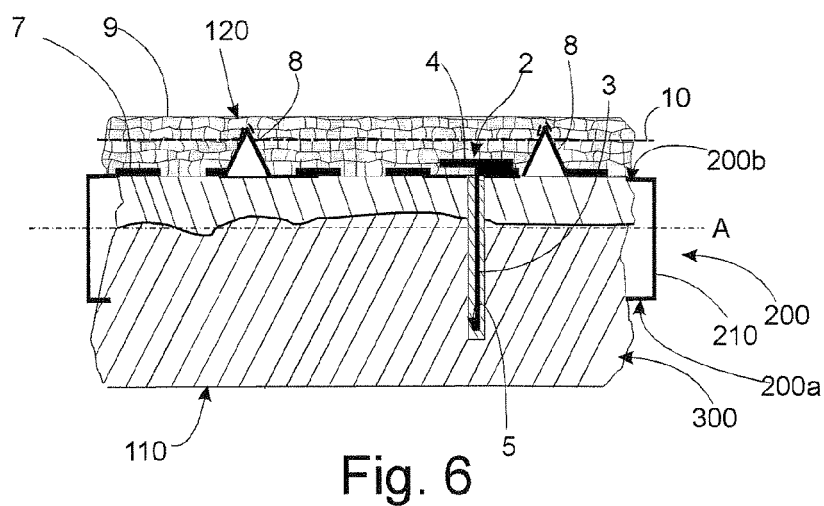
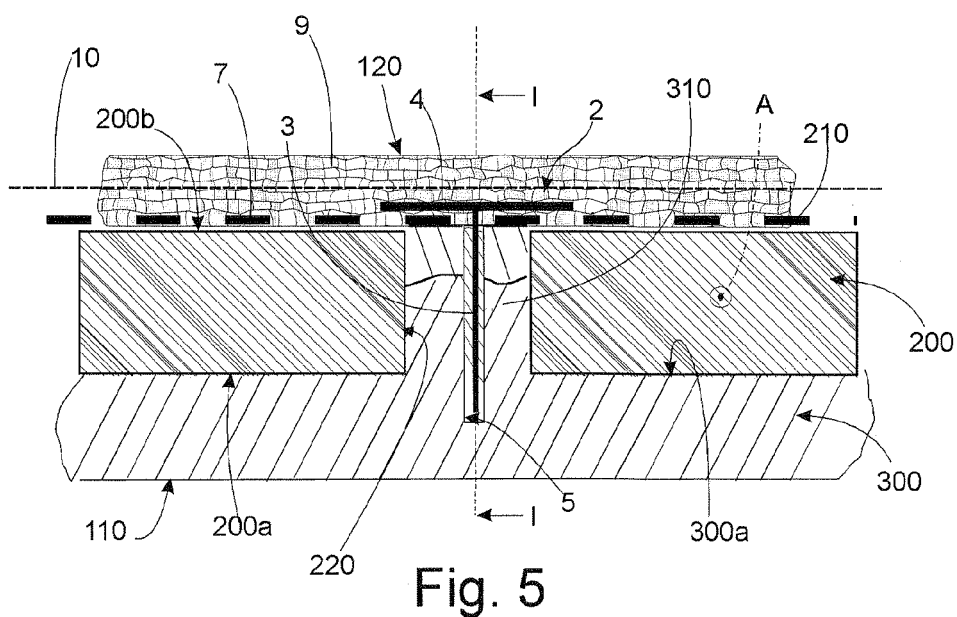
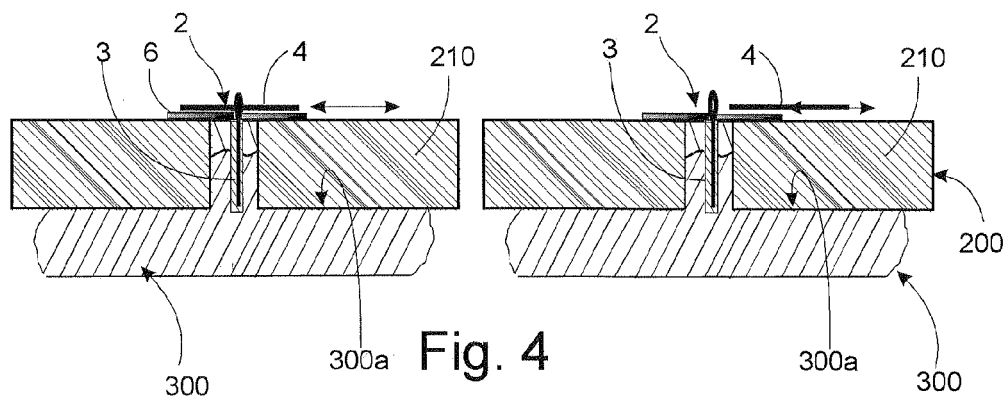
making a blind hole (5) in the plaster layer (300) at a fixing point;

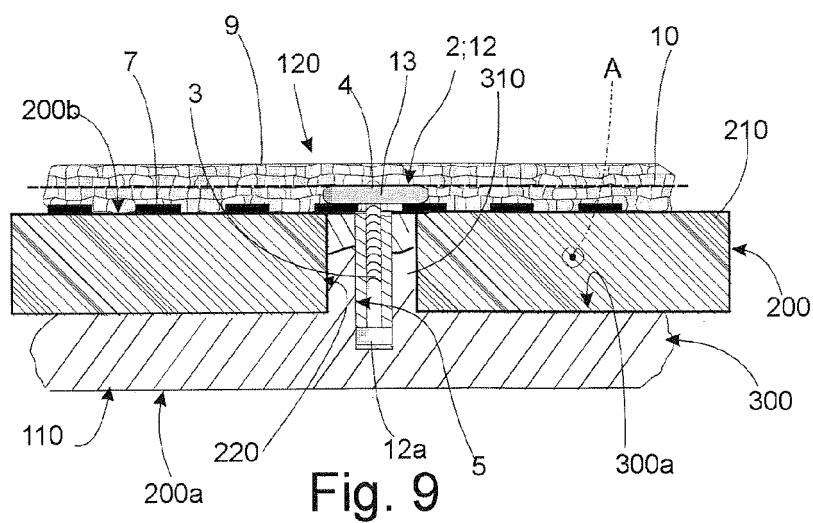
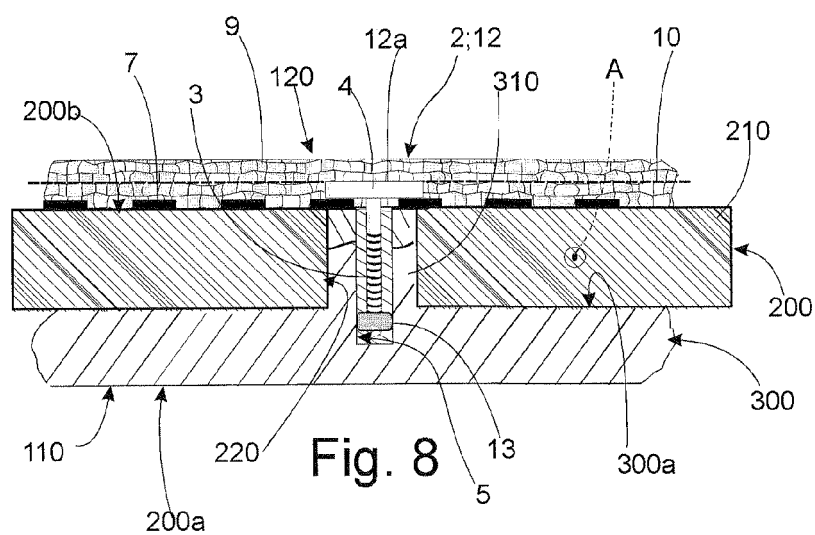
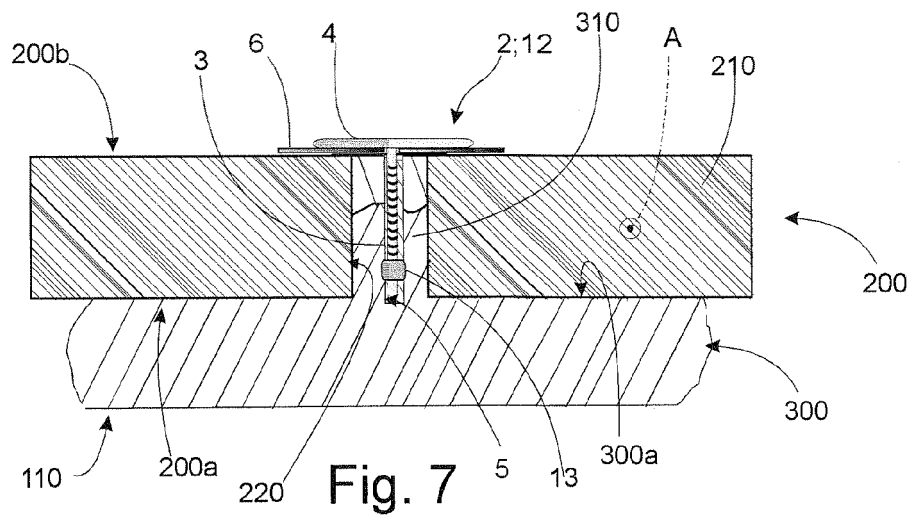
injecting a given amount of strengthening resin (15) into the hole (5) so as to increase both the hardness and the elasticity of the plaster layer (300) which surrounds at least one segment of the hole (5);

engaging the anchoring portion of the anchoring member (2) within the hole (5) so as to place the supporting portion resting on the plaster-holding timber frame (200);

injecting a fixing mixture into said hole (5) so as to embed said anchoring portion of the anchoring member (2) in the hole (5) to make the anchoring member (2) integral with the plaster layer (300).







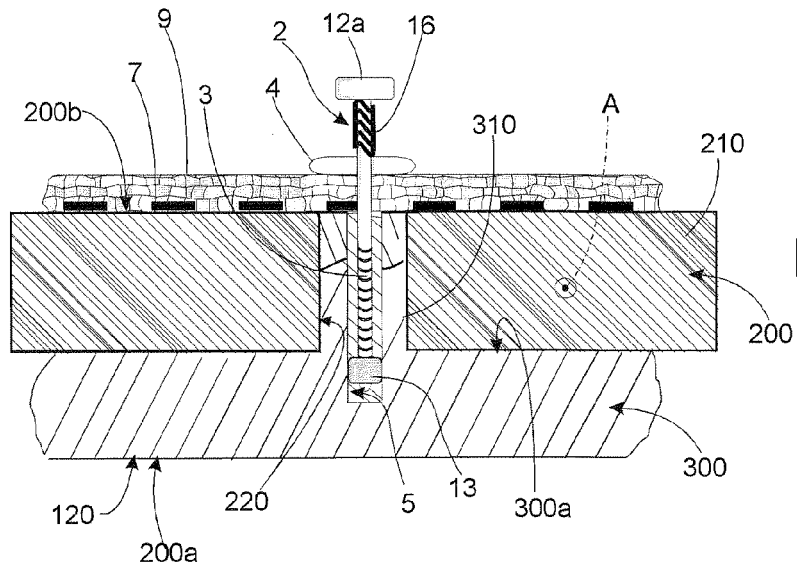


Fig. 10

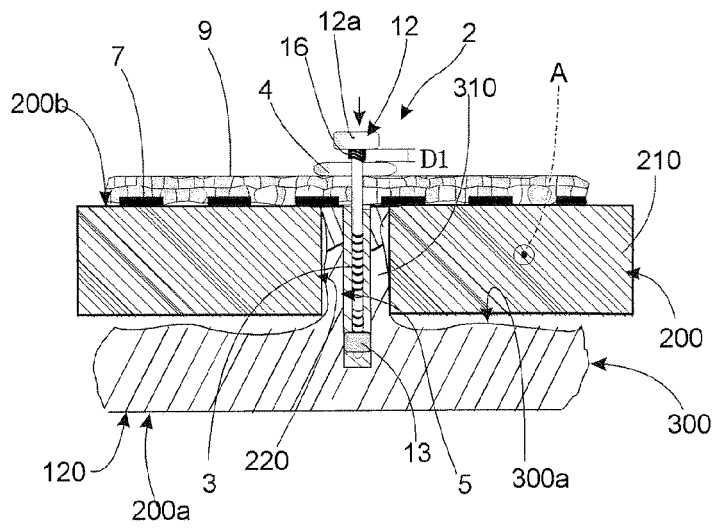


Fig. 11

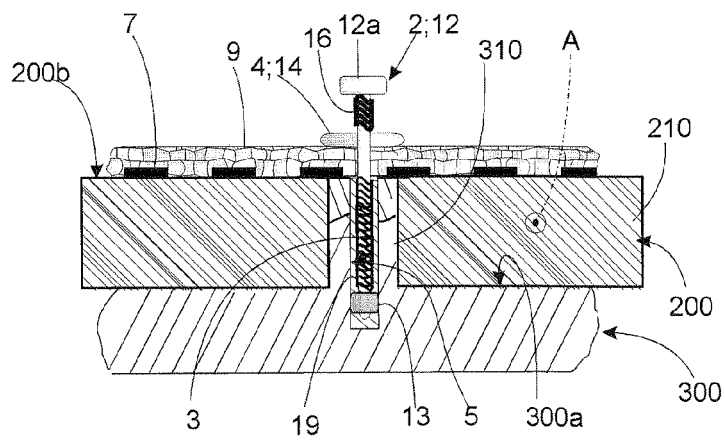


Fig. 12

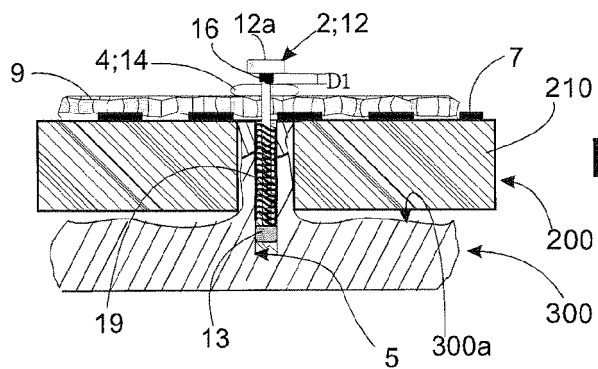


Fig. 13

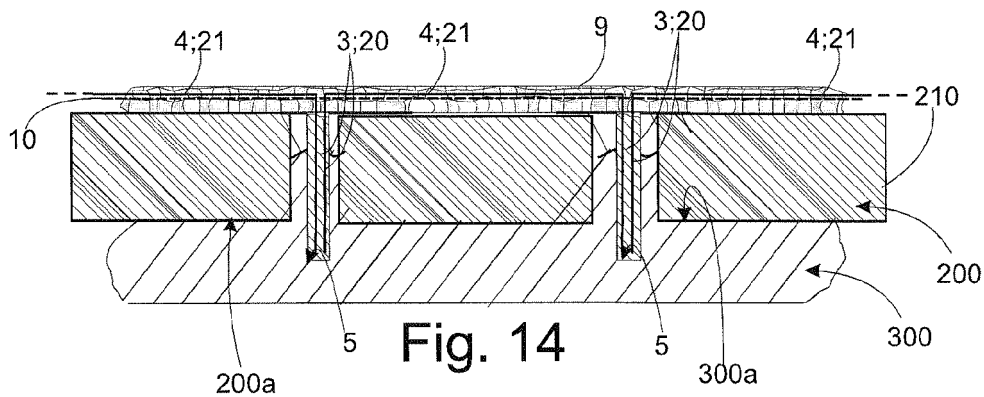


Fig. 14

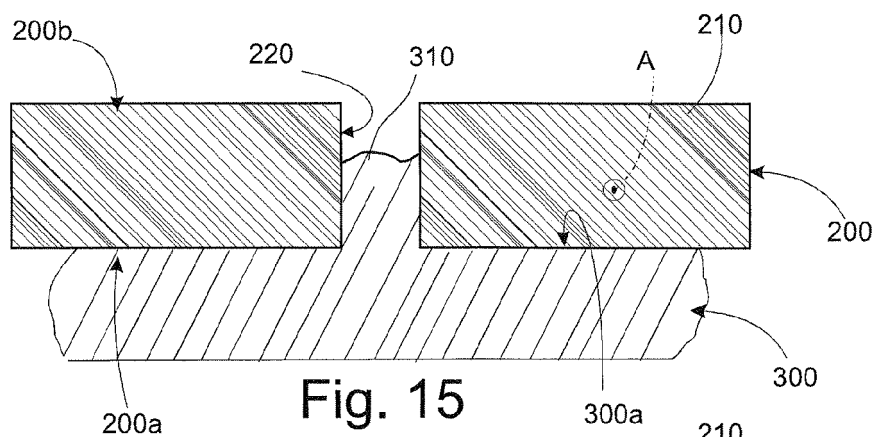


Fig. 15

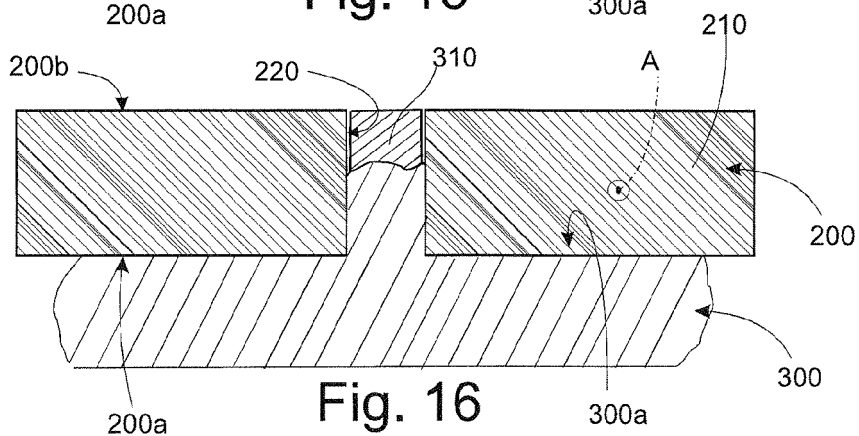


Fig. 16

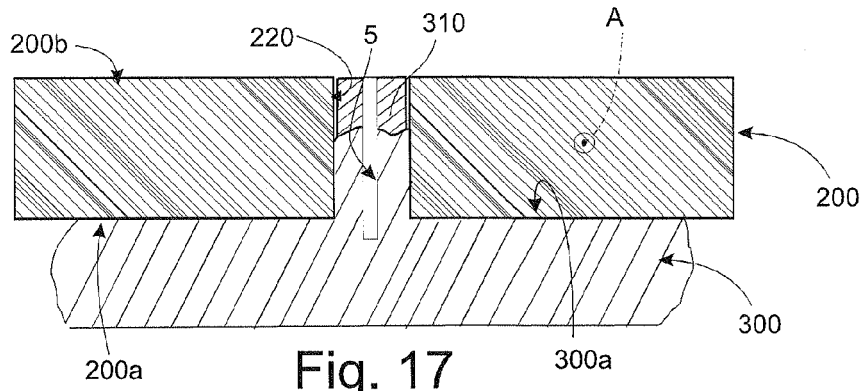


Fig. 17

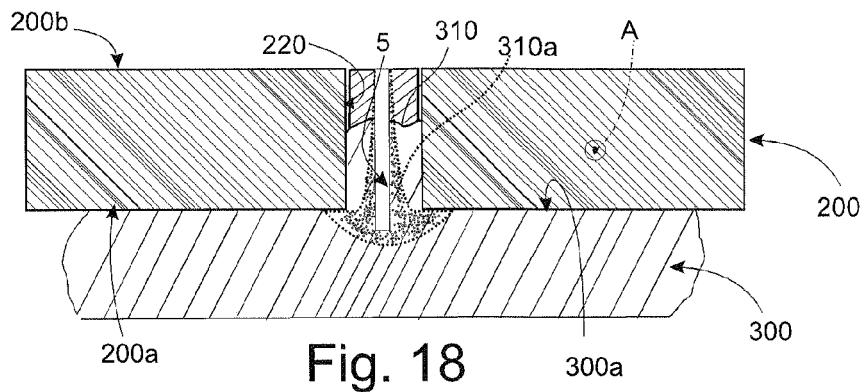


Fig. 18

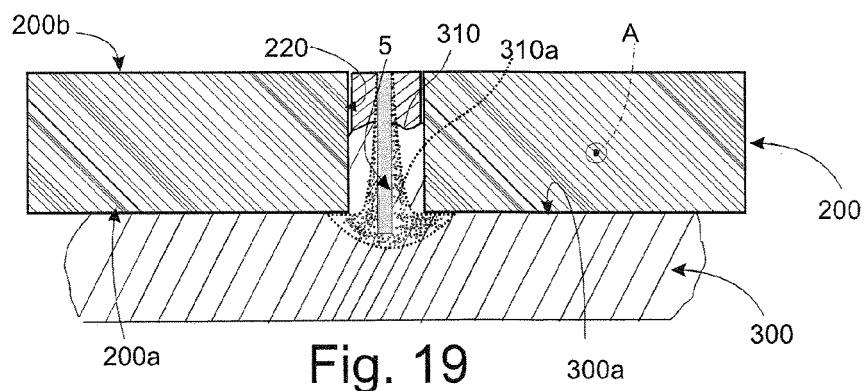


Fig. 19

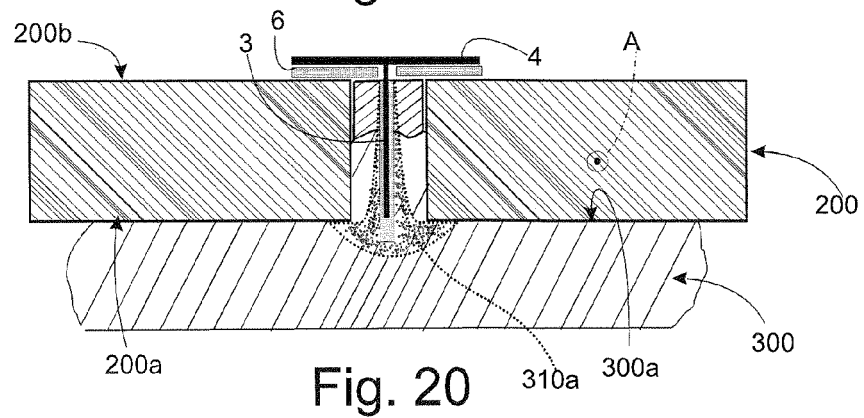
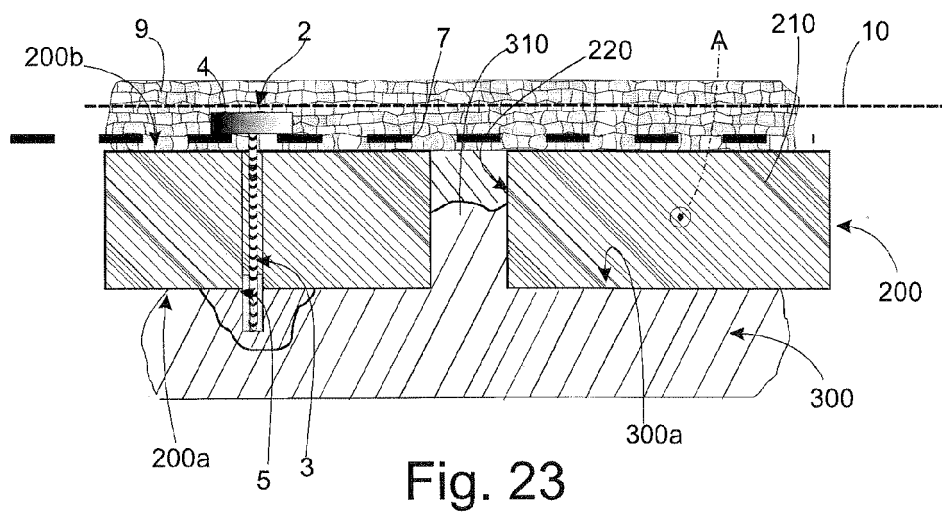
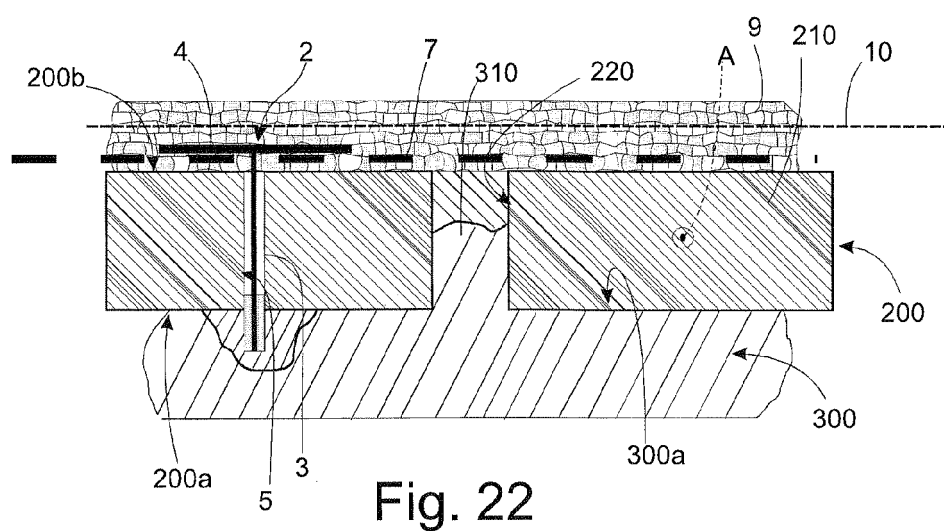
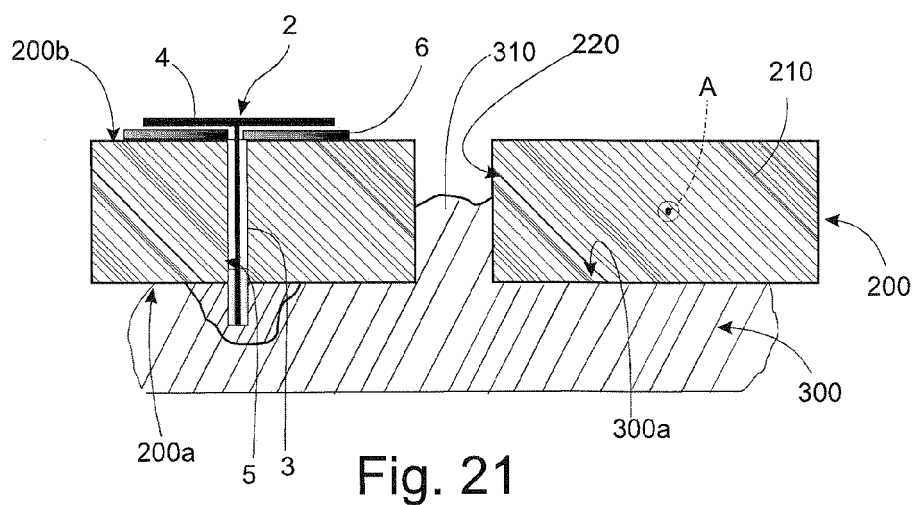


Fig. 20





EUROPEAN SEARCH REPORT

Application Number
EP 13 18 0003

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	US 2007/029025 A1 (BRENNAN RORY E [US] ET AL) 8 February 2007 (2007-02-08) * the whole document *	1-3,7-9, 15	INV. E04G23/02 E04F13/02
X	US 2 598 984 A (ESLICK FREDERICK M) 3 June 1952 (1952-06-03) * column 2, line 4 - column 3, line 49 *	1-3,7,8, 13,14	
A	* column 3, line 73 - column 4, line 6 *	15	
	* figures 2,3,4,6,8 *		
A	US 733 671 A (MURRAY MARTIN [US]) 14 July 1903 (1903-07-14) * page 1, line 75 - line 97 *	1,15	
	* figures 1,2,5 *		
			TECHNICAL FIELDS SEARCHED (IPC)
			E04G E04F E04C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 November 2013	Examiner Arsac England, Sally
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 18 0003

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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22-11-2013

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